CLAIMS

What is claimed is:

1. A purge gas mixture supply system, comprising:

a purge gas source;

a water source; and

a purge gas mixture generator comprising a moisturizer configured to add moisture to a purge gas, wherein said moisturizer comprises a first region containing a purge gas flow and a second region containing water wherein the first and second regions are separated by a gas-permeable membrane that is substantially resistant to liquid intrusion.

2. The supply system of Claim 1, wherein the membrane is comprised of a thermoplastic polymer.

3. The supply system of Claim 1, wherein the membrane is comprised of a perfluorinated polymer.

4. The supply system of Claim 3, wherein the perfluorinated polymer is polytetrafluoroethylene.

5. The supply system of Claim 1, wherein the membrane forms a hollow fiber and wherein one of the first and second regions is within the fiber and the other of the first and second regions is outside the fiber.

6. The supply system of Claim 5, wherein the moisturizer comprises:

a) a bundle of a plurality of gas-permeable hollow fiber membranes having a first end and a second end, said membranes having an outer surface and an inner surface, said inner surface comprising one of the first and second regions;

b) each end of said bundle potted with a liquid tight seal forming an end structure with a surrounding housing wherein the fiber ends are open to fluid flow;

c) said housing having an inner wall and an outer wall, wherein the inner wall defines the other of the first and second regions between the inner wall and the hollow fiber membranes;

d) said housing having a purge gas inlet connected to the purge gas source and a purge gas mixture outlet; and

e) said housing having a water inlet connected to the water source and a water outlet, wherein either the purge gas inlet is connected to the first end of the bundle and the purge gas mixture outlet is connected to the second end of the bundle or the water inlet is connected to the first end of the bundle and the water outlet is connected to the second end of the bundle,

and wherein said purge gas mixture comprises at least one purge gas and the moisture.

7. A purge gas mixture supply system, comprising:

a purge gas source;

a water source; and

a purge gas mixture generator comprising a moisturizer configured to add moisture to a purge gas, wherein said moisturizer comprises:

a) a bundle of a plurality of perfluorinated gas-permeable thermoplastic hollow fiber membranes having a first end and a second end, said membranes having an outer surface and an inner surface, said inner surface comprising a lumen;

b) each end of said bundle potted with a liquid tight perfluorinated thermoplastic seal forming a unitary end structure with a surrounding perfluorinated thermoplastic housing wherein the fiber ends are open to fluid flow;

c) said housing having an inner wall and an outer wall, wherein the inner wall defines a fluid flow volume between the inner wall and the hollow fiber membranes;

d) said housing having a purge gas inlet connected to the purge gas source and a purge gas mixture outlet; and

e) said housing having a water inlet connected to the water source and a water outlet, wherein either the purge gas inlet is connected to the first end of the bundle and the purge gas mixture outlet is connected to the second end of the bundle or the water inlet is connected to the first end of the bundle and the water outlet is connected to the second end of the bundle,

and wherein said purge gas mixture comprises at least one purge gas and the moisture.

8. The supply system of Claim 7, further comprising a heating device for the water.

9. The supply system of Claim 7, wherein the purge gas source comprises a purifier device.

10. The supply system of Claim 9, wherein the purifier device is regenerable.

11. The supply system of Claim 10, wherein the purge gas source comprises two purifier devices and wherein the purifier devices are connected in parallel.

12. The supply system of Claim 7, wherein the hollow fiber membranes are selected from the group consisting of:

a) hollow fiber membranes having a porous skinned inner surface, a porous outer surface and a porous support structure between;

b) hollow fiber membranes having a non-porous skinned inner surface, a porous outer surface and a porous support structure between;

c) hollow fiber membranes having a porous skinned outer surface, a porous inner surface and a porous support structure between; and

d) hollow fiber membranes having a non-porous skinned outer surface, a porous inner surface and a porous support structure between.

13. The supply system of Claim 12, wherein the hollow fiber membrane outer diameter is about 350 microns to about 1450 microns.

14. The supply system of Claim 12, wherein the hollow fiber membranes are hollow fiber membranes having a porous skinned inner surface, a porous outer surface and a porous support structure between; or hollow fiber membranes having a porous skinned outer surface, a porous inner surface and a porous support structure between; and the porous skinned surface pores are from about 0.001 microns to about 0.005 microns in diameter.

15. The supply system of Claim 7, wherein the first and second ends of the bundle are potted with a liquid tight perfluorinated thermoplastic seal forming a single unitary end structure comprising both the first and second ends with a surrounding perfluorinated thermoplastic housing wherein the fibers of the ends are separately open to fluid flow.

16. The supply system of Claim 7, wherein said supply system is capable of operation at a purge gas flow rate of at least about 30 standard liters per minute and a temperature of at least about 90°C.

17. The supply system of Claim 7, wherein the purge gas mixture generator is heated for a sufficient length of time at a temperature sufficient to

substantially remove compounds that volatilize at temperatures of about 100°C or less.

18. A method of humidifying a purge gas, comprising passing the purge gas through a moisturizer for a period sufficient to humidify the purge gas, wherein the moisturizer comprises a first region containing a purge gas flow and a second region containing water wherein the first and second regions are separated by a gas-permeable membrane that is substantially resistant to liquid intrusion.

19. The method of Claim 18, wherein the membrane is comprised of a thermoplastic polymer.

20. The method of Claim 18, wherein the membrane is comprised of a perfluorinated polymer.

21. The method of Claim 20, wherein the perfluorinated polymer is polytetrafluoroethylene.

22. The method of Claim 18, wherein the membrane forms a hollow fiber and wherein one of the first and second regions is within the fiber and the other of the first and second regions is outside the fiber.

23. The method of Claim 22, wherein the moisturizer comprises:

a) a bundle of a plurality of gas-permeable hollow fiber membranes having a first end and a second end, said membranes having an outer surface and an inner surface, said inner surface comprising one of the first and second regions;

b) each end of said bundle potted with a liquid tight seal forming an end structure with a surrounding housing wherein the fiber ends are open to fluid flow;

c) said housing having an inner wall and an outer wall, wherein the inner wall defines the other of the first and second regions between the inner wall and the hollow fiber membranes;

d) said housing having a purge gas inlet connected to the purge gas source and a purge gas mixture outlet; and

e) said housing having a water inlet connected to the water source and a water outlet, wherein either the purge gas inlet is connected to the first end of the bundle and the purge gas mixture outlet is connected to the second end of the bundle or the water inlet is connected to the first end of the bundle and the water outlet is connected to the second end of the bundle.

24. A method of humidifying a purge gas, comprising passing the purge gas through a moisturizer for a period sufficient to humidify the purge gas, wherein the moisturizer comprises:

a) a bundle of a plurality of perfluorinated thermoplastic hollow fiber membranes having a first end and a second end, said membranes having an outer surface and an inner surface, said inner surface comprising a lumen;

b) each end of said bundle potted with a liquid tight perfluorinated thermoplastic seal forming a unitary end structure with a surrounding perfluorinated thermoplastic housing wherein the fiber ends are open to fluid flow;

c) said housing having an inner wall and an outer wall, wherein the inner wall defines a fluid flow volume between the inner wall and the hollow fiber membranes;

d) said housing having a purge gas inlet connected to a purge gas source and a purge gas outlet; and

e) said housing having a water inlet connected to a water source and a water outlet, wherein either the purge gas inlet is connected to the first end of the bundle and the purge gas outlet is connected to the second end of the bundle or the water inlet is connected to the first

end of the bundle and the water outlet is connected to the second end of the bundle,

thereby obtaining a humidified purge gas.

25. The method of Claim 24, wherein the water is heated in or prior to entering the moisturizer.

26. The method of Claim 24, wherein the purge gas source comprises a purifier device.

27. The method of Claim 26, wherein the purifier device is regenerable.

28. The method of Claim 27, wherein the purge gas source comprises first and second purifier devices and wherein the purifier devices are connected in parallel.

29. The method of Claim 28, wherein the purge gas is purified by either the first or the second purifier device and wherein the other purifier device is regenerated.

30. The method of Claim 24, wherein the hollow fiber membranes are selected from the group consisting of:

a) hollow fiber membranes having a porous skinned inner surface, a porous outer surface and a porous support structure between;

b) hollow fiber membranes having a non-porous skinned inner surface, a porous outer surface and a porous support structure between;

c) hollow fiber membranes having a porous skinned outer surface, a porous inner surface and a porous support structure between; and

d) hollow fiber membranes having a non-porous skinned outer surface, a porous inner surface and a porous support structure between.

31. The method of Claim 30, wherein the hollow fiber membrane outer diameter is about 350 microns to about 1450 microns.

32. The method of Claim 30, wherein the hollow fiber membranes are hollow fiber membranes having a porous skinned inner surface, a porous outer surface and a porous support structure between or hollow fiber membranes having a porous skinned outer surface, a porous inner surface and a porous support structure between and the porous skinned surface pores are from about 0.001 microns to about 0.005 microns in diameter.

33. The method of Claim 24, wherein the first and second ends of the bundle are potted with a liquid tight perfluorinated thermoplastic seal forming a single unitary end structure comprising both the first and second ends with a surrounding perfluorinated thermoplastic housing wherein the fibers of the ends are separately open to fluid flow.

34. The method of Claim 24, wherein the temperature of the water is at least about 30°C.

35. The method of Claim 34, wherein the temperature of the water is at least about 50°C.

36. The method of Claim 24, wherein the flow rate of the purge gas is at least about 20 standard liters per minute.

37. The method of Claim 36, wherein the flow rate of the purge gas is at least about 60 standard liters per minute.

38. The method of Claim 24, wherein the relative humidity of the humidified purge gas is at least about 20%.

39. The method of Claim 38, wherein the relative humidity of the humidified purge gas is at least about 50%.

40. The method of Claim 39, wherein the humidified purge gas is substantially saturated with moisture.

41. The method of Claim 24, wherein the purge gas entering the moisturizer comprises no greater than about 1 part per billion (ppb) contaminants and wherein the humidified purge gas leaving the moisturizer comprises no greater than about 1 ppb contaminants.

42. The method of Claim 41, wherein the purge gas entering the moisturizer comprises no greater than about 100 parts per trillion (ppt) contaminants and wherein the humidified purge gas leaving the moisturizer comprises no greater than about 100 ppt contaminants.

43. The method of Claim 42, wherein the purge gas entering the moisturizer comprises no greater than about 1 ppt contaminants and wherein the humidified purge gas leaving the moisturizer comprises no greater than about 1 ppt contaminants.

44. A lithographic projection apparatus, comprising:

an illuminator configured to provide a projection beam of radiation;

a support structure configured to support a patterning device, the patterning device configured to pattern the projection beam according to a desired pattern;

a substrate table configured to hold a substrate;

a projection system configured to project the patterned beam onto a target portion of the substrate; and

at least one purge gas supply system configured to provide a purge gas to at least part of the lithographic projection apparatus, the at least one purge gas supply system comprising:

a purge gas mixture generator comprising a moisturizer configured to add moisture to a purge gas, wherein the moisturizer comprises a first region containing a purge gas flow and a second region containing water wherein the first and second regions are separated by a gas-permeable membrane that is substantially resistant to liquid intrusion, the purge gas mixture generator configured to generate a purge gas mixture, which purge gas mixture comprises at least one purge gas and the moisture; and

a purge gas mixture outlet connected to the purge gas mixture generator configured to supply the purge gas mixture to the at least part of the lithographic projection apparatus.

45. A lithographic projection apparatus, comprising:

an illuminator configured to provide a projection beam of radiation;

a support structure configured to support a patterning device, the patterning device configured to pattern the projection beam according to a desired pattern;

a substrate table configured to hold a substrate;

a projection system configured to project the patterned beam onto a target portion of the substrate; and

at least one purge gas supply system configured to provide a purge gas to at least part of the lithographic projection apparatus, the at least one purge gas supply system comprising:

a purge gas mixture generator comprising a moisturizer configured to add moisture to a purge gas, wherein the moisturizer comprises:

a) a bundle of a plurality of perfluorinated thermoplastic hollow fiber membranes having a first end and a second end, said membranes having an outer surface and an inner surface, said inner surface comprising a lumen;

b) each end of said bundle potted with a liquid tight perfluorinated thermoplastic seal forming a unitary end structure with a surrounding perfluorinated thermoplastic housing wherein the fiber ends are open to fluid flow;

c) said housing having an inner wall and an outer wall, wherein the inner wall defines a fluid flow volume between the inner wall and the hollow fiber membranes;

d) said housing having a purge gas inlet connected to the purge gas source and a purge gas mixture outlet; and

e) said housing having a water inlet connected to the water source and a water outlet, wherein either the purge gas inlet is connected to the first end of the bundle and the purge gas mixture outlet is connected to the second end of the bundle or the water inlet is connected to the first end of the bundle and the water outlet is connected to the second end of the bundle,

the purge gas mixture generator configured to generate a purge gas mixture, which purge gas mixture comprises at least one purge gas and the moisture; and

a purge gas mixture outlet connected to the purge gas mixture generator configured to supply the purge gas mixture to the at least part of the lithographic projection apparatus.

46. A method for providing a purge gas to at least part of a lithographic projection apparatus comprising:

an illuminator configured to provide a projection beam of radiation;

a support configured to support a patterning device, the patterning device configured to pattern the projection beam according to a desired pattern;

a substrate table configured to hold a substrate; and

a projection system configured to project the patterned beam onto a target portion of the substrate;

the method comprising:

generating a purge gas mixture which comprises at least one purge gas and moisture by adding moisture to a purge gas with a moisturizer, wherein the moisturizer comprises a first region containing a purge gas flow and a second region containing water wherein the first and second regions are separated by a gas-permeable membrane that is substantially resistant to liquid intrusion, and

supplying the purge gas mixture to at least a part of the lithographic projection apparatus.

47. A method for providing a purge gas to at least part of a lithographic projection apparatus comprising:

an illuminator configured to provide a projection beam of radiation;

a support configured to support a patterning device, the patterning device configured to pattern the projection beam according to a desired pattern;

a substrate table configured to hold a substrate; and

a projection system configured to project the patterned beam onto a target portion of the substrate;

the method comprising:

generating a purge gas mixture which comprises at least one purge gas and moisture by adding moisture to a purge gas with a moisturizer, wherein the moisturizer comprises:

a) a bundle of a plurality of perfluorinated thermoplastic hollow fiber membranes having a first end and a second end, said membranes having an outer surface and an inner surface, said inner surface comprising a lumen;

b) each end of said bundle potted with a liquid tight perfluorinated thermoplastic seal forming a unitary end structure with a surrounding perfluorinated thermoplastic housing wherein the fiber ends are open to fluid flow;

c) said housing having an inner wall and an outer wall, wherein the inner wall defines a fluid flow volume between the inner wall and the hollow fiber membranes;

d) said housing having a purge gas inlet connected to a purge gas source and a purge gas mixture outlet; and

e) said housing having a water inlet connected to a water source and a water outlet, wherein either the purge gas inlet is connected to the first end of the bundle and the purge gas mixture outlet is connected to the second end of the bundle or the water inlet is connected to the first end of the bundle and the water outlet is connected to the second end of the bundle, and

supplying the purge gas mixture to at least a part of the lithographic projection apparatus.